23 TERMINAL

The primary task of air traffic control (ATC) in the terminal domain is to ensure that aircraft are safely separated and sequenced within the airspace immediately surrounding one or more airports. Terminal automation systems provide the terminal radar approach control (TRACON) facilities with capabilities for controlling arriving, departing, and overflight aircraft and provide tower facilities with terminal radar aircraft situation displays. TRACON facility controllers, with support from a co-located traffic management unit (TMU) (at some high-activity locations), manage the flow of air traffic in the terminal airspace.

The future terminal architecture accommodates the projected air traffic growth through automation enhancements and procedural changes to improve capacity, reduce maintenance costs, and provide the foundation for future enhancements. A combination of ground and airborne automation capabilities will allow flexible departure and arrival routes and reduce and/or eliminate speed and altitude restrictions in the terminal domain. A major driver of the terminal architecture is to lower operations and maintenance costs by evolving toward maximum commonality between offshore and domestic air traffic services.

As described in Section 22, Oceanic and Offshore, the ATC automation systems at offshore sites (Guam, San Juan, and Honolulu) will evolve toward automation systems commonality with the terminal domain. The concept of commonality is that the offshore facilities will evolve to the terminal infrastructure and the applications software as appropriate, but they will also utilize domain- and site-specific capabilities necessary for operational suitability.

The FAA and the Department of Defense (DOD) will replace all of their terminal automation systems in the NAS with the Standard Terminal Automation Replacement System (STARS). STARS is an all-digital system based on an open system architecture.

The terminal architecture will evolve to provide the following enhanced capabilities:

- Improved arrival and departure sequencing based on surface traffic, airline preferences, and traffic flow information
- Integrated display of weather and aircraft positions based on primary/secondary radar, and automatic dependent surveillance (ADS) information
- Conformance monitoring, conflict detection, and conflict probe functionality
- Automated exchange of real-time flight data among aircraft, ATC facilities, airline ramp control, and airline operations centers (AOCs) to support collaboration
- Integration of surface and terminal automation.

These enhancements will allow for improvements such as:

- Reduction and/or elimination of terminal area speed and altitude restrictions
- Flexible departure and arrival route structures and possible reduced separation.

23.1 Terminal Architecture Evolution

The terminal architecture evolves from an infrastructure composed of various FAA and DOD automation systems to a standard infrastructure—STARS. The evolution of STARS includes preplanned product improvements (P^{3}I) to support enhanced functionality, as well as periodic upgrades to ensure future maintainability and supportability.

During a four-step evolution, the terminal architecture will integrate capabilities that will also satisfy many offshore automation requirements. The following diagrams show each evolutionary step in a logical or functional representation without any intention of implying a physical design or solution.

The STARS deployment program will install systems at 170 FAA and 36 DOD terminal facilities over approximately 6 years. The current equipment (i.e., automated terminal radar system (ARTS IIA, IIE, IIIA, IIIE)) and associated displays and peripherals and the DOD programmable indicator data processor (PIDP)) will be decommissioned. STARS P^{3}Is will incrementally provide new functionality and enhancements (see Figure 23-1).

PART III

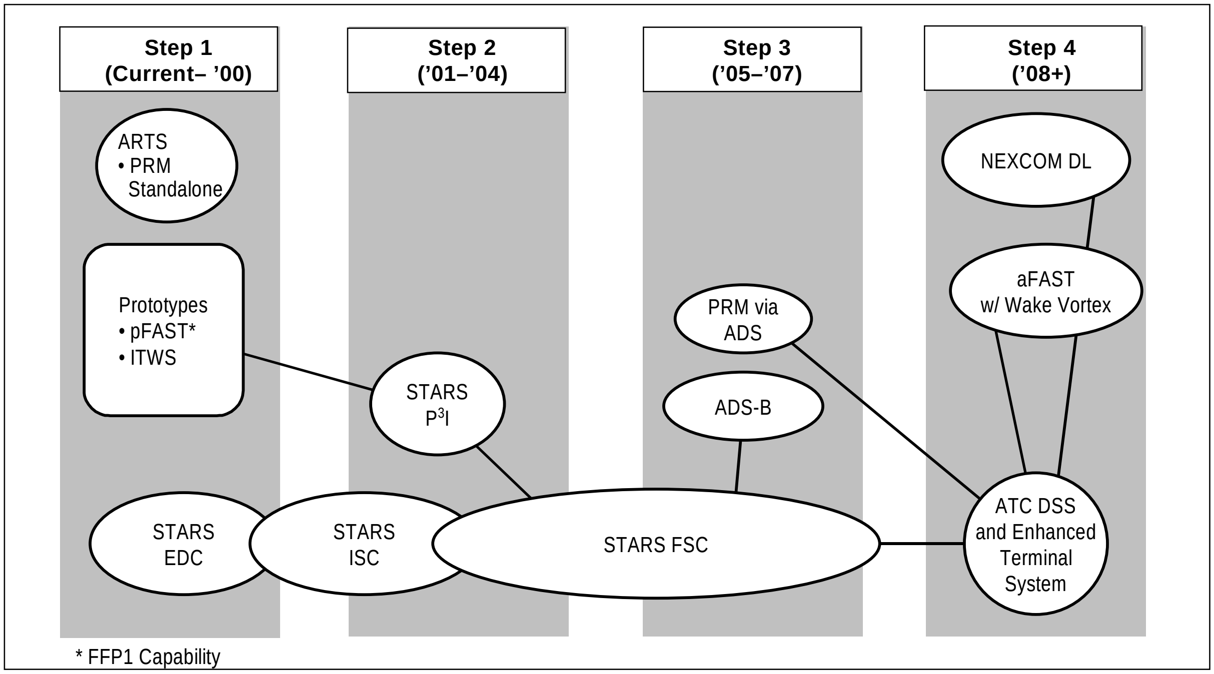

Figure 23-1. Terminal Architecture Evolution

23.1.1 Terminal Architecture Evolution—Step 1 (Current–2000)

In this step, current terminal automation systems will begin to be replaced with more modern systems that provide the foundation for future enhancements (see Figure 23-2). Step 1 consists of the current automation systems and the initial STARS implementation.

Current Automation Systems

The current terminal automation systems consist of computer processing and display systems that are used in conjunction with airport surveillance radars. The current systems used within the TRACON are FAA configurations of the ARTS and the DOD PIDP (collectively referred to as ARTS). ARTS began with the ARTS I in 1964, then evolved into several configurations. The ARTS IIA and ARTS IIE are designed to provide automation support to air traffic controllers at small to medium-sized TRACONs, and the ARTS IIIA and ARTS IIIE are designed for larger TRACONs.

ARTS satisfies the requirements for tracking and identifying aircraft. In addition, the ARTS IIIA, IIE, and IIIE systems provide additional safety functions, such as conflict alert, Mode-C intruder (MCI), and minimum safe altitude warning (MSAW). Conflict alert and MCI are automated safety functions that detect unsafe proximity between aircraft pairs and provide visual and aural alerts to controllers. MSAW detects proximity between tracked aircraft and terrain and/or obstructions and provides controllers visual and aural alerts. ARTS IIA systems are being updated to ARTS IIE in order to provide these safety functions.

ARTS acquires and maintains aircraft identification, predicts future locations and altitudes, displays the information directly to a controller, and transfers the information to the next controller responsible for the aircraft. It associates the transponder code received from the aircraft via the secondary radar surveillance system with the assigned transponder code contained in the flight plan (received from the en route host computer).

ARTS provides TRACON controllers with continuous alphanumeric information on radar and data displays. This information, displayed in a data block, includes the aircraft identity, altitude, the type of aircraft, ground speed, any special equipage of the aircraft, and, if applicable, the emergency status of the aircraft.

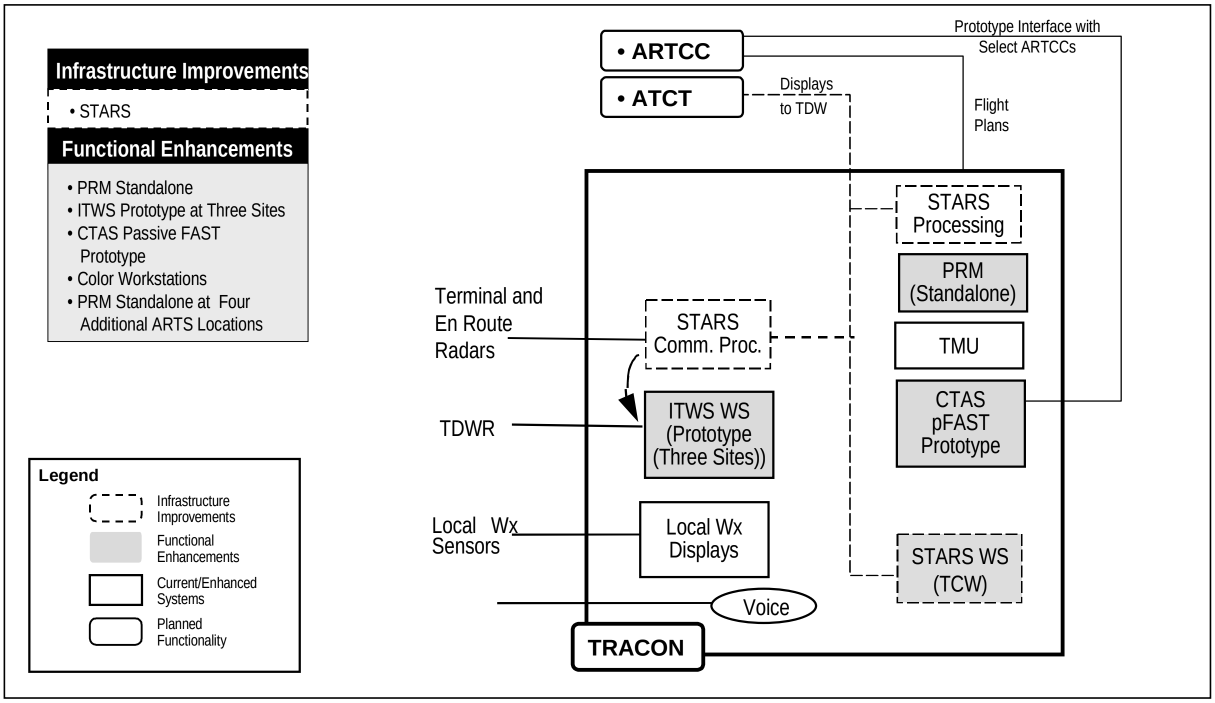

Figure 23-2. Terminal Architecture Evolution—Step 1 (Current–2000)

Specific ARTS versions also support use of the Final Monitor Aid (FMA), Converging Runway Display Aid (CRDA), and Controller Automation Spacing Aid (CASA). FMA monitors aircraft on final approaches to parallel runways and provides controllers visual and aural alerts when approaching aircraft are predicted to enter a nontransgression zone between parallel runways. CRDA and CASA are algorithms and display features that assist controllers in merging arriving traffic into a final approach sequence. CRDA and CASA functionality assists controllers in visualizing the relationships between aircraft on different flight paths in the terminal airspace and adjusting spacing between aircraft to maximize capacity. CRDA is used at airports with converging runways that have straight-in approaches. CASA is used at airports with curved approaches.

The digital bright radar indicator tower equipment (DBRITE) system is a tower display that presents radar/beacon, weather, and ARTS data to tower controllers.

Flight Data Input Output (FDIO) is a separate system that provides a capability for terminal controllers to enter and retrieve aircraft flight plans into and from the en route host computer and to print paper flight progress strips for use by terminal and tower controllers.

Other Current Capabilities

Several other capabilities currently exist or will be introduced into the terminal domain during Step 1.

Air Traffic Management. Within certain high-activity TRACONS, a TMU serves as the interface with the enhanced traffic management system (ETMS), the backbone of the current national traffic flow management (TFM) system (see Section 20, Traffic Flow Management). The TMU provides a projection of aircraft demand for primary airports via the monitor alert functions and the aircraft situation display. Monitor/alert informs the traffic management coordinator when projected traffic flows will exceed capacity and provides a means for adjusting flows in coordination with the Air Traffic Control System Command Center (ATCSCC) and the AOCs.

Center TRACON Automation System (CTAS)/ passive Final Approach Spacing Tool (pFAST). A CTAS/pFAST prototype is in operation at the Dallas-Fort Worth TRACON, interfacing with the ARTS-IIIE. Based on its mature status as a research and development prototype program, CTAS/pFAST was selected for deployment at additional sites as a part of Free Flight Phase 1 Core Capabilities Limited Deployment (FFP1 CCLD) to provide early benefits to ATC and NAS users in the terminal domain. pFAST is an automation tool that assists terminal controllers in sequencing and spacing arrival traffic. pFAST integrates radar sensor, flight plan, aircraft performance, and weather data. The pFAST processor algorithms sequence and merge aircraft approaching the airport from different directions. Aircraft are merged into a steady arrival stream, which balances runway utilization, increases traffic-flow efficiency, and helps pilots conserve fuel. pFAST sends the aircraft and sequencing data for display at controller workstations. The pFAST functionality is modular and will be developed in several incremental builds that will progressively increase the tool's sophistication.

Integrated Terminal Weather System (ITWS). ITWS, currently a prototype system at three locations (Dallas-Fort Worth, Orlando, and Memphis TRACONs), functions as a weather server in the terminal domain. ITWS integrates weather from terminal Doppler weather radar (TDWR) and airport surveillance radars (ASRs) for display at terminal facilities. It also provides alerts and short-term forecasts of terminal weather conditions (see Section 26, Aviation Weather).

Parallel Runway Monitor (PRM). PRM allows independent simultaneous parallel approaches under instrument meteorological conditions (IMC) for parallel runways spaced from 3,400 to 4,300 feet. The PRM consists of an electronically scanned surveillance radar with 1-second update and a high-resolution color display. PRM requires track and flight plan data from the terminal automation system. Currently a one-way interface from ARTS to the PRM has been defined.

PRM provides controllers with visual and aural alerts when an approaching aircraft is predicted to blunder into the nontransgression zone between the runways. It was commissioned at Minneapolis-St. Paul in 1997 and St. Louis in 1998 and is scheduled for implementation at three additional terminal facilities (New York (John F. Kennedy Airport), Philadelphia, and Atlanta).

Tower Interface Systems

Two Tower prototype programs, the Airport Movement Area Safety System (AMASS) and the surface movement advisor (SMA), require an interface with the terminal automation system to receive track and flight information.

Airport Movement Area Safety System. AMASS, currently a prototype system at the Detroit and St. Louis airports, will be deployed to 34 airports. It alerts tower controllers to potential aircraft conflicts on the airport surface via audible cautions and warnings and visual information superimposed on the airport surface detection equipment (ASDE)-3 display (see Sections 16, Surveillance, and 24, Tower and Airport Surface).

Surface Movement Advisor. The SMA prototype developed at Atlanta is planned for implementation at selected facilities. The prototype shares information among air traffic, the airlines, and the operations community. However, to provide early benefits to users as part of FFP1 CCLD, SMA has been redefined to provide a form of limited collaborative decisionmaking (CDM) capability. Specifically, initial SMA for FFP1 CCLD will provide aircraft arrival, departure, and airport status information via ARTS to airline ramp control operators (see Section 24, Tower and Airport Surface).

STARS Implementation Phase

Current automation systems will be unable to meet growing traffic demands or readily incorporate new functionality. The FAA needs an open, expandable terminal automation platform that can accommodate current and future needs. STARS will replace the various ARTS systems at FAA TRACONs and PIDP at DOD facilities with modern displays and distributed processing network architectures. STARS will also replace DBRITE with the tower display workstation (TDW) to provide equivalent ATC operational functionality.

STARS provides a standard automation architecture that is scalable across all TRACON facilities. It will reduce costs for software changes, improve software portability and documentation, reduce hardware and software maintenance and training, and provide the capacity for future growth. STARS will also provide color displays for terminal and tower controllers (i.e., terminal controller workstations (TCWs) and TDWs) to increase the amount of information that can be displayed and to improve data discrimination. STARS requires digitized radar data from surveillance systems (see Section 16, Surveillance) to process tracking and will provide multiple radar sensor tracking and mosaic display.

STARS functionality will be delivered in three capability configurations. The early display configuration (EDC) will interface with the existing ARTS via the automation interface adapter (AIA). The ARTS backroom equipment provides the processing capability using STARS displays.

The STARS initial system capability (ISC) and final system capability (FSC) configurations modernize the automation of terminal facilities and provide a single automation solution, while overcoming the deficiencies of the current terminal automation systems. (FSC will not be implemented until Step 2.) STARS also provides an evolutionary path to provide new functionality as it becomes available. FSC will incorporate FMA, CRDA, CASA, and a maintenance interface to the operational control centers (OCCs). The OCC interface will be used for remote monitoring and control of STARS.

23.1.2 Terminal Architecture Evolution—Step 2 (2001–2004)

During this period, deployment of STARS to all FAA TRACONs will continue, as will national deployments of CTAS/pFAST, PRM, AMASS, and ITWS (see Figure 23-3). STARS P^{3}I planning includes a limited set of FDP capabilities to enhance STARS. STARS will replace the Microprocessor En Route Automated Tracking System (MicroEARTs) systems at two offshore facilities (Honolulu center radar approach control (CERAP) and Guam) (see Section 22, Oceanic and Offshore).

Functionality enhancements to STARS will be provided in a series of “packages.” It is anticipated that these packages will be implemented one per year for several years. The first planned package includes interfaces to pFAST, PRM, AMASS, and SMA. These systems, which had been interfaced to ARTS as prototypes, will begin national deployment. The All Purpose Structured EUROCONTROL Radar Information Exchange (ASTERIX), free-form text, and terminal controller position-defined airspace will also be implemented. Definition of these STARS enhancements follow:

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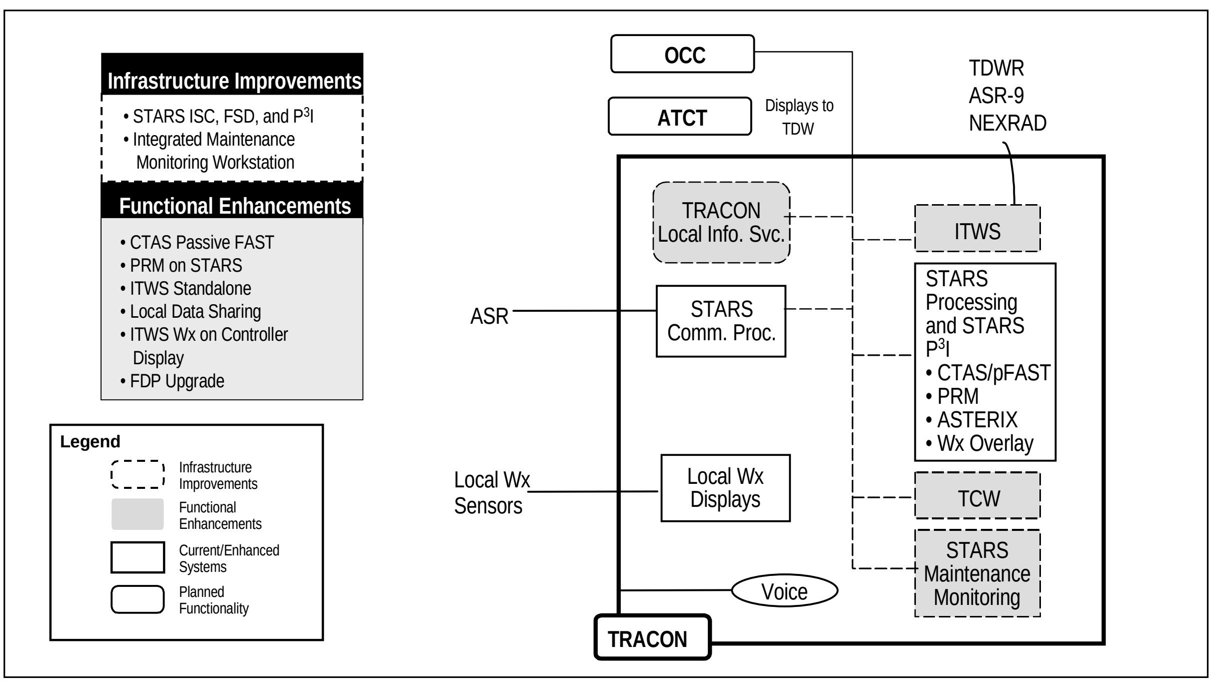

Figure 23-3. Terminal Architecture Evolution—Step 2 (2001–2004)

All Purpose Structured EUROCONTROL Radar Information Exchange (ASTERIX). This is a digital surveillance message format currently being standardized under the leadership of EUROCONTROL.[1] ASTERIX will permit a sensor to transmit surveillance data with increased precision and a unique aircraft identification code in the target position report. This identification will be used for surveillance processing/tracking and separation assurance function enhancements. ASTERIX will enable other surveillance processing enhancements, such as selective interrogation (SI) and processing automatic dependent surveillance-broadcast (ADS-B) data (see Section 16, Surveillance). ASTERIX will be implemented with the interface to the ASR-11, ATCBI-6, and Mode-S radar systems being procured.

Free-Form Text. This function allows the controller to input and place alphanumeric text anywhere on the STARS TCW/TDW displays. The function replaces handwritten notes that are used during the controller relief briefing. Free-form text is a safety enhancement to ensure information is available and in view of the controller.

Terminal Controller Position-Defined Airspace. This allows the controller to define an airspace (i.e., temporarily restricted airspace) and display it on the TCW/TDW. This capability ensures safe operations in the vicinity of special aviation activities (e.g., parachute jumping) and will facilitate other safety critical operations, such as release of instrument flight rules (IFR) traffic at uncontrolled airports, release of volumes of airspace to other sectors, and providing reminder messages for procedures temporarily changed due to equipment outages or weather conditions.

Candidates for other P^3I packages to be implemented during this period include:

Automated Barometric Pressure Entry (ABPE). Currently, controllers manually enter the barometric pressure reference used by the terminal automation system. The current setting is obtained from direct-reading instruments or digital altimeter setting indicators (DASIs) or the nearest weather reporting station. The altimeter setting affects an aircraft's altitude displayed to the controller. ABPE adds a STARS interface to the Automated Surface Observing System (ASOS) (or the DASI) for automated input of local barometric pressures, thereby reducing controller workload and the possibility of data entry error.

STARS/STARS Interfacility Interface. Currently, the interface between terminal automation systems is via the en route Host computer system. STARS-to-STARS interfacility communications will allow a STARS facility to exchange data directly with up to seven other STARS facilities. This change will increase operational and technical efficiency and reduce the Host workload.

Flight Data Input/Output Integration Into STARS. The current FDIO in the TRACON facilities will be replaced. Integrating FDIO into STARS will include FDIO keyboard and display functionality at the TCW and a flight strip printer.

Surveillance Processing Enhancements. STARS inherent capabilities allow use of enhanced surveillance algorithms, information, and processing functions. These improved surveillance capabilities depend on the ASTERIX message format described above. The implementation of ASTERIX enables tracking, conflict alert, and Mode-C intruder alert algorithms to be improved due to increased precision of position reporting, the surveillance file numbers correlating targets to tracks, and the time stamps for target reports.

ITWS Weather on Controller Displays. Initially, ITWS will be a stand-alone system with the weather data available to terminal controllers on separate displays. Later, ITWS weather information will be displayed on STARS. This capability will provide convective and hazardous weather detection and prediction information (from ITWS outboard processing) directly at controller positions, thereby increasing efficiency and safety. At sites that are not receiving ITWS, the ASR-9 weather system processor (WSP) will be interfaced to STARS to display windshear information on the TCW.

Traffic Management Interface Enhancements. The ETMS upgrade is a two-way interface that will permit display of ETMS data on the TCW.

1. The European Organization for the Safety of Air Navigation.

Another candidate functionality for implementation (depending upon funding) during this time period is:

Flight Data Processor (FDP) Upgrade. Currently, flight data are processed by the en route Host computer at the ARTCCs. The offshore sites are not within ARTCC airspace, and thus are not supported by this FDP capability. A limited set of FDP capabilities is required for STARS to fully replace the current MicroEARTs and unique local FDP systems at Honolulu, San Juan, and Guam (see Section 22, Oceanic and Offshore). Also, FDP capabilities in STARS will reduce dependence on the en route automation system.

23.1.3 Terminal Architecture Evolution—Step 3 (2005–2007)

STARS will be delivered to a third offshore facility (San Juan) during this step.

Electronic flight data management (FDM) will be introduced through a prototype flight object processor. TRACON data will be routinely available throughout the NAS via local information sharing and the NAS-wide information network. (see Section 19, NAS Information Architecture and Services for Collaboration and Information Sharing). Real-time surveillance data will be distributed from the sensors to TRACONs and from the TRACONs to other ATC facilities.

Introducing aircraft and surface vehicle ADS-B information processing and surveillance data fusion will allow enhancements to the terminal tracking and safety functions. Surveillance data processing of aircraft and surface vehicles will facilitate integration of terminal and tower data from a single automation source such as STARS (see Figure 23-4).

Surveillance Data Processor (SDP)

As secondary radar systems with selective interrogation (SI) capability are implemented, ground automation system changes will be incorporated to effectively interface with these systems.

TRACON automation will permit acceptance and processing of ADS-B position reports and the integration and fusion of ADS-B data with radar data. TRACON automation processing will be expanded to integrate terminal radar and surface surveillance data, including ground vehicles operating on the airport surface movement area. The end result is the integration of airborne and surface surveillance information on the tower displays.

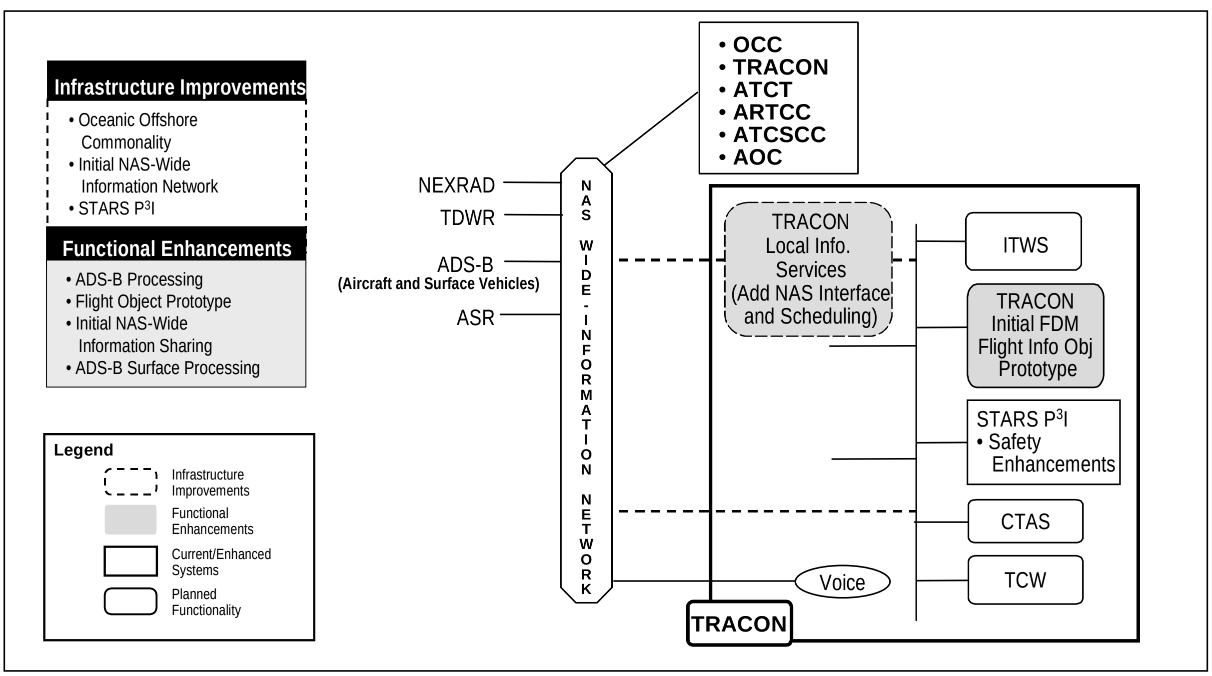

Figure 23-4. Terminal Architecture Evolution—Step 3 (2005–2007)

The integration of ADS-B data with data from surveillance sensors will require development of a multisensor fusion tracker. This ability to combine target reports from multiple sources to form a single track takes advantage of overlapping sensors and ADS-B data. This capability will improve the accuracy and availability of aircraft position data, potentially increasing the efficiency and safety of terminal operations and reducing reliance on any one sensor. Development of algorithms for terminal and en route data fusion will be done jointly, and fused surveillance data will be available for distribution to other TRACONs and ARTCCs via the NAS-wide information network.

PRM currently depends on a special electronically scanned radar to provide the rapid updates necessary to perform its monitoring function. Because of the update rates available with ADS-B, TRACON automation will be able to provide PRM functionality at many more facilities at a significantly lower implementation cost.

Safety Enhancements

Conflict alert, MCI, and MSAW are existing safety functions. The enhanced surveillance processing and tracking previously discussed will improve the probability of detection and reduce the false alarm rate associated with these functions. Merging approach and departure traffic will improve the effectiveness of conflict alert and runway incursion logic, and the display of both types of traffic on the same controller screen will improve situational awareness and safety. Incorporating intent data acquired through ADS-B will also improve conflict alert performance.

Flight Object Processor Prototype and Flight Data Management (FDM)

Currently, the ARTCC automation performs flight data processing for all aircraft within its assigned airspace, including aircraft under TRACON control. The limited set of prototype STARS FDP capabilities developed in Step 2 for the offshore facilities will be enhanced to provide FDM capabilities. This will be a coordinated effort with the en route FDM development and may become the model for the ultimate NAS-wide FDM. This FDM is an evolution from today's flight data processing capability that permits use of flight object data (defined in Section 19, NAS Information Architecture and Services for Collaboration and Information Sharing). This capability at TRACONs will eventually reduce terminal system dependence on ARTCC automation.

As local systems are replaced or new systems developed, commercial data base management systems will be used. This will enable data sharing (e.g., flight plan information, radar and weather data, maintenance information) between the various local terminal automation systems and applications (see Section 19, NAS Information Architecture and Services for Collaboration and Information Sharing).

23.1.4 Terminal Architecture Evolution—Step 4 (2008–2015)

The logical terminal architecture is illustrated in Figure 23-5. The evolution of the terminal automation system toward a common hardware and software infrastructure for the offshore facilities will be accomplished in Step 4. Oceanic offshore automation system functionality will be fully integrated into the enhanced terminal offshore system. An FDM will be implemented to replace existing offshore and terminal FDP capabilities. The FDM expands on the FDP functionality and will use flight objects to disseminate flight status and traffic management information. The enhanced terminal and offshore system will provide an improved surveillance data processor for aircraft and surface vehicles. This automation system will allow more integrated surface and airspace operations, enabling the airport IFR capacity to more closely approach visual flight rule (VFR) capacity.

A common, modern platform infrastructure will provide for development of many advanced ATC decision support systems (DSSs). The controller, traffic flow managers, airline operation centers, pilots, and other NAS users will have access to the same DSS and information, which will enable a collaborative decisionmaking capability. The TRACON ATC DSS will integrate conformance monitoring, conflict resolution, and conflict probe capabilities as a coordinated set of controller tools. The reliance on paper flight strips will decline. pFAST capabilities will be upgraded to active FAST (aFAST) with greater precision in aircraft sequencing through recommended speed and

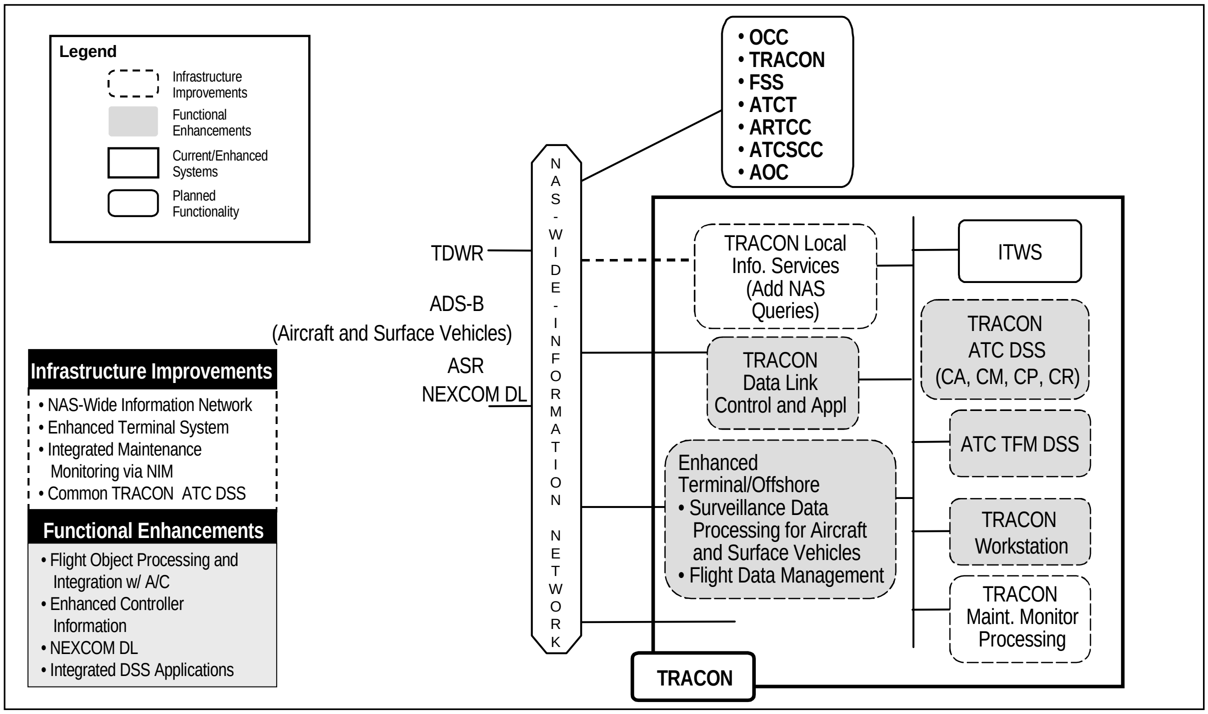

Figure 23-5. Terminal Architecture Evolution—Step 4 (2008–2015)

heading adjustments and aircraft wake vortex information in the spacing calculations to increase safety.

Data link capabilities will migrate from the service provider capability in the tower domain to the next-generation communication systems (e.g., NEXCOM). Full ATN-compliant controller-pilot data link communications (CPDLC) Build 3 service will support air-ground data exchange. The enhanced terminal automation system will use data link for communications and ADS-B to provide more accurate aircraft position reporting. This will allow more efficient use of terminal airspace and application of revised separation assurance standards. Eventually, with improved ground-based separation assurance and decision-making tools, used in conjunction with advanced cockpit display of surrounding traffic, pilots may be able to fly self-separation maneuvers during IFR conditions in the terminal area. This provides the capability to achieve VFR runway acceptance rates during IFR conditions.

An upgraded TDW that supports the integration of tower automation functions with terminal automation will be provided (see Section 24, Tower and Airport Surface).

The NAS-wide information network will conform to NAS-wide data standards, incorporate multi-level access control and data partitioning, provide data security, allow real-time data accessibility via queries, and assume all data routing and distribution functions, including data link. (see Section 19, NAS Information Architecture and Services for Collaboration and Information Sharing).

23.2 Summary of Capabilities

Evolutionary refinements to terminal automation systems will result in DSSs that support flexible departure and arrival routes by using satellite-based navigation and improved communications and surveillance capabilities. Surveillance data processing will be performed in the terminal domain using a common processing system for both dependent surveillance data and radar/beacon data for ground and airborne traffic (see Figure 23-6).

The NAS-wide information network will provide exchange of real-time flight data among aircraft, ATC facilities, and AOCs, enabling a collaborative decisionmaking capability. Terminal automation improvements will also provide new interfaces for communications with external systems (e.g., CTAS/pFAST, PRM, SMA, AMASS, and

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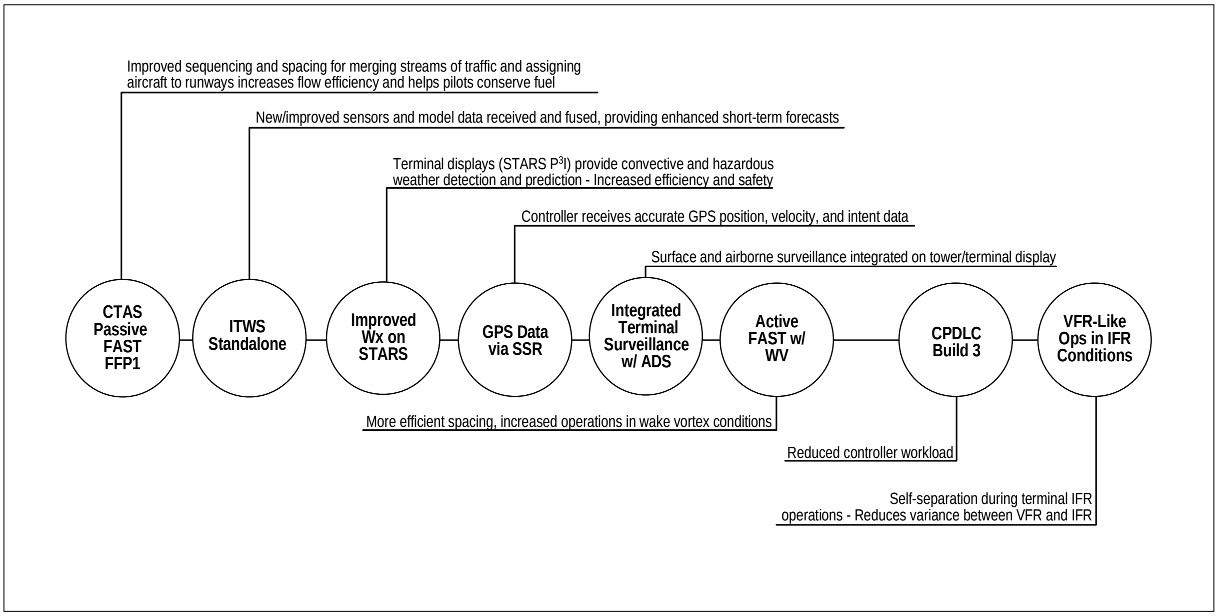

Figure 23-6. Terminal Architecture Evolution

ITWS). These new interfaces will add the capability to provide automation-generated data, such as tracks and flight plans to external systems, as well as a capability to receive and process data from external systems. In addition, the improvements will support surveillance system enhancements, improved weather display, data link, and conflict alert and Mode-C intruder alert enhancements.

The terminal automation suite will process surveillance data for surface vehicular traffic as well as aircraft for use in both the tower and terminal areas. The terminal automation suite will migrate to an enhanced terminal/offshore automation system that will evolve to a full set of TRACON ATC DSSs and TFM DSSs. The NAS-wide information network will improve collaborative decisionmaking between FAA and users.

The terminal automation system will use a digital data communications channel between terminal controllers and the aircraft in terminal airspace. This channel will supplement the controller's existing voice channel, and will allow the controller to move many of the regular and routine functions from the voice (very high frequency (VHF)) radio communications to a second, parallel communications channel. Studies have shown that this terminal data link application, computer-human interface (CHI), and second data communications channel will help terminal controllers to communicate with pilots more effectively, manage terminal airspace more efficiently, and to potentially enable significant user cost savings.

23.3 Human Factors

New hardware and software tools will improve the way controllers conduct terminal operations and provide traffic management services. Human factors efforts will focus on enhancing controller performance through:

- Upgrading the human interface with communications, new surveillance sources, and DSSs
- Using results from simulations and cognitive modeling for decision support tools to facilitate aircraft, ATC, and airline operations real-time flight data sharing
- Enhancing procedures for using surface, airline operations, and traffic-flow information for collaborative decisions involving arrival and departure sequencing
- Improving displays of new information involving airport surface movement, aircraft tracks, flight plans, and weather
- Changing training concepts to support such tools and new technologies as data link.

23.4 Transition

The terminal domain transition schedule is shown in Figure 23-7. These capabilities will be deployed during the transition:

- STARS deployment
- STARS P3I
  - – CTAS/pFAST, PRM, AMASS, SMA interfaces, Free-Form text, and ASTERIX
  - – PRM internal to STARS
  - – CTAS/a FAST
- Surface ADS-B, terminal-offshore integration
- Data link via NEXCOM
- SDP, SDP-to-off-shore
- Initiate STARS Hardware Upgrade 1 (Repeat at 6-year intervals)
- Enhanced terminal functionality
- Terminal-tower integration.

23.5 Costs

The FAA estimates for research, engineering, and development (R,E&D); facilities and equipment (F&E); and operations (OPS) life-cycle costs for the terminal architecture from 1998 through 2015 are presented in constant FY98 dollars in Figure 23-8.

23.6 Watch Items

Achieving terminal functionality and operational benefits within the schedules and budgets described in the architecture depends on the funding and success of the following funding activities:

- Timely deployment of STARS to solve the infrastructure replacement problems in the near term and provide a bridge to the new capabilities of the reengineered terminal system
- Demonstrate, as a part of Safe Flight 21, the ability of ground automation systems to process improved surveillance, intent, aircraft state, and wind data from both Mode-S downlink and ADS, to merge these data with radar data, and to display this information to controllers with an acceptable CHI. Results of these demonstrations would include processing algorithms and CHI standards that could then be incorporated into the terminal core functionality between 2005 and 2008.
- Success of the FFP1 CCLD prototypes for the terminal domain (CTAS/pFAST).

The budget for incorporating some of the future functionality is related to developing common al-

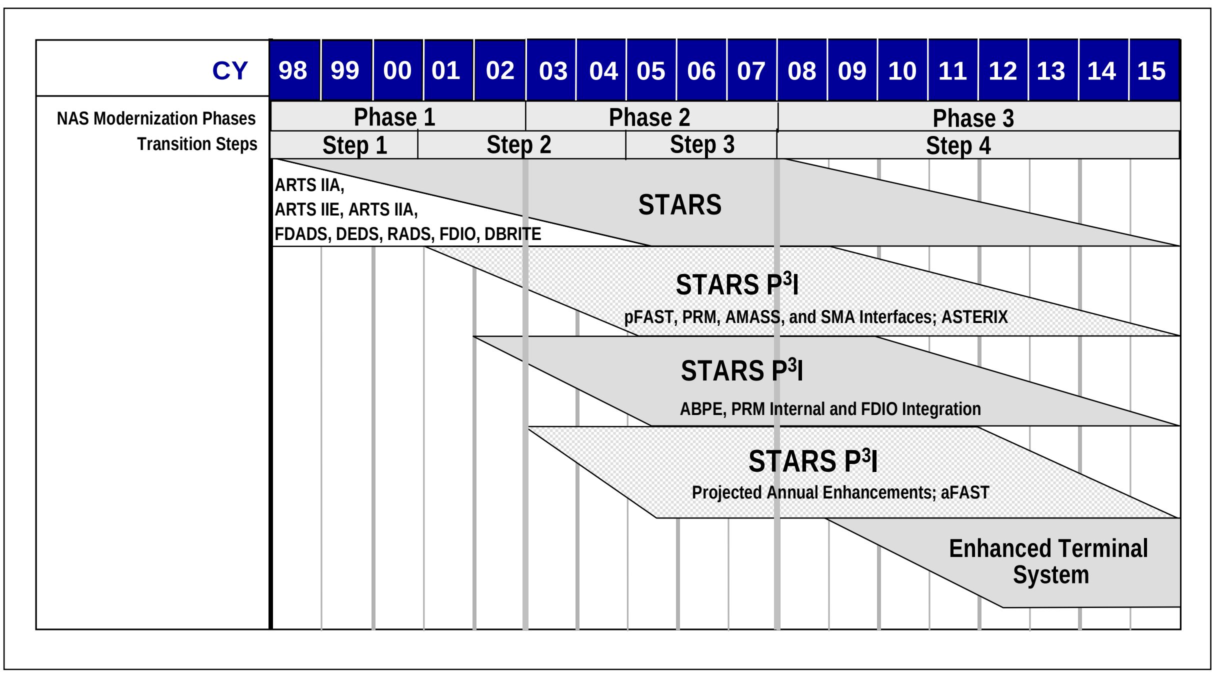

Figure 23-7. Terminal Automation Transition

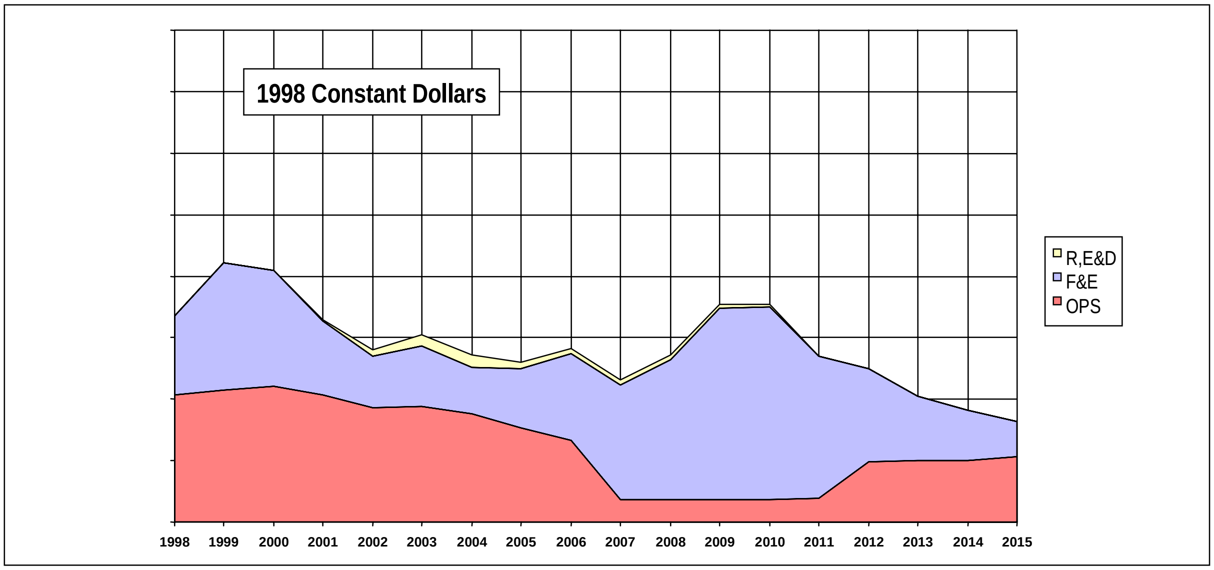

Figure 23-8. Estimated Terminal Automation Costs

gorithms to provide this functionality across domains where appropriate. Areas where common functionality across domains is anticipated are:

- Common surveillance processing and ADS/ radar data fusion in the terminal, en route, and surface domains
- Common weather services
- Common flight object processing
- Common functionality in some ATC DSSs and safety-related tools.

It is understood that this development process will increase dependencies between domains, but it is also understood that current budgets do not allow separate development in each domain. Therefore, it is essential that many of these efforts begin in the near-term to reduce long-term production risks.